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A C ASE STUDY O F HE AVY DOWNPOUR O VER NE INDIA

1. The North Eastern Region (NER) comprises the eight Indian states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. Normally the monsoon sets in over the Assam region during the first week of June and withdraws by the second week of October. The two Indian stations that receive the heaviest rainfall, *viz*., Cherrapunji and Mawsynram, are located just to the south of the Brahmaputra basin. Although rises in the semi-arid of south Tibet, the Brahmaputra with its 34 tributaries frequently experiences severe floods during the summer monsoon months June-September due to its passage through the wettest region of India. These floods bring death and devastation not only to Assam but also to the neighbouring country Bangladesh.

Brahmaputra and Borak are two river systems of NER. The mighty river Brahmaputra originates from the glacial womb of Kailash range of Himalayas whose elevation is about 5300 m. It flows 1625 kms Eastward along Tibetan Autonomous region of China, 918 kms along India (through Arunachal Pradesh and Assam) and 337 kms along Bangladesh before falling into Bay of Bengal. On the other hand Borak river originates from hill ranges of Borail (Assam), Nagaland and Manipur. It flows along Bangladesh and meets Brahmaputra. More than 100 tributaries contribute to the river Brahmaputra from northern and southern hilly terrain. On the other hand, about 15 tributes to the river Borak. Considering all the tributaries, sixteen catchments (Table 1) have been identified. Catchments numbers 1 to 15 comprises the

TABLE 1

Catchments in the NE region

Catchment No	Name of the Catchment
1	Dehang at Pasighat
2	Lohit at Dholla
3	Brahmaputra at Dibrugarh
4	Buridihang at Khowang
5	Subhansiri at Badatighat
6	Brahmaputra at Neamatighat
7	Dhansiri at Golaghat
8	Brahmaputra at Tezpur
9	Jia-Bharali at NT Rd Xing
10	Dhansiri (N) at Rly Bdge Xing
11	Kapili at Kampur
12	Brahmaputra at Guwahati
13	Manas/ Beki at Rd Bridge
14	Brahmaputra at Goalpara
15	Brahmaputra at Dhubri
16	Barak at Silchar

Fig. 1. Station Network Map of Basin

Brahmaputra valley, while catchment Number 16 constitutes Borak valley. It is only the unique physical scenario of the world, where such a composite river catchments are collocated and had been remaining known for its highest rainfall record zone (Fig. 1).

The monsoon rains from June to September account for more than 70% of the annual rainfall. The summer rains are mainly depend on the position of monsoon trough (axis) extending from northwest India to the head of the Bay of Bengal. In the course of its north-south oscillations in summer when this axis moves closer to the foothills of the Himalayas, heavy precipitation is caused in Assam and adjoining highlands (Goswami, 1992). The orographic effect on rainfall is a significant feature of the NE region which causes a significant variability in the spatial distribution of rainfall.

Annual rainfall normal depicts different rainfall zone (Mahapatra *et al* ., 2008). Rainfall exceeding 250 cm features out these zones *viz*., west Zone covering Goalpara, Dhubri, Mathanguri, NE Zone covering North Lakhimpur, Passighat, Tezu, Dholabazar, Southern zone covering, Cherrapunjee (1087 cm), Haflong, Silchar and southern part of Mizoram. The central zone covering Lumding Diphu with less than 150 cm of rainfall. Snow fall and frozen condition also occur occasionally in certain years over high altitudes of Arunachal Pradesh. NE region is a unique in nature due to the variability in topography which results the monsoon rainfall highly variable in space.

Heavy rainfall events generally lead to flood which causes major loss to the society. Therefore critical study of heavy rainfall events needs special importance in respect of flood. In the present study a 10 heavy rainfall events for NE region has been studied synoptically during the period 2002-2007 in the Monsoon season.

2. The rainfall and synoptic data are used for the study during the flood period 2002-2007 in the north eastern region of India. Daily Area weighted rainfall and accumulated rainfall are computed by using isohyetal technique for the monsoon season. Ten cases of heaviest downpour out of daily rainfall have been taken for detail study in respect of meteorology. Successive rainy days of a storm are analysed separately on daily basis. For synoptic situations SLC of 0000 UTC are analysed.

3. Daily downpour for the entire region for SW monsoon season (2002-2007) and average quantity of downpour water during the season has been worked out as 1,735,529 metric tons/day by using isohyetal techniques. The quantity of downpour varies from 0 to 14,263,061 metric tons/day over the NE region.

For the computation of this study the raingauge network map and the sub catchment boundary is shown on Fig. 1. Ten cases of heaviest downpour in one day has been taken and discussed during the period.

Case 1

Date 06 July 2004

A sea level trough was passing from Punjab to North East Assam on SLC of 0000 UTC. There was no other significant system. Consequent upon a very heavy down pour during period (2002-2007) over NE region was observed by the observation of R/F at 0830 hrs on the following day, *i.e*., 07 July 2004. The AAP's value area and quantity of down pour water in metric tons catchment wise is shown in the Table 2. This day down pour water over NE region is 5.92 times the average daily downpour during monsoon seasons of 2002-2007.

Case 2

Date 07 July 2004

A sea level trough was passing from Punjab to NE Assam on SLC of 0000 UTC. There was no other

TABLE 2

AAP and Quantity of downpour

Catchment No.	Area (km^2)	06 July 2004		07 July 2004		08 July 2004		09 July 2004		10 July 2004	
		AAPs (mm)	Downpour (Metric tons)	AAPs (mm)	Downpour (Metric tons)	AAPs (mm)	Downpour (Metric tons)	AAPs (mm)	Downpour (Metric tons)	AAPs (mm)	Downpour (Metric tons)
1	15341	168.9	2,591,095	143.6	2202968	246.7	3784625	193.2	2963881	116.1	1781090
2	14007	37.4	523,862	45.8	641521	55.5	777389	154.0	2157078	39.8	557479
3	16008	100.3	1,605,602	77.7	1243822	135.4	2167483	120.9	1935367	63.0	1008504
4	7337	24.5	179,757	23.6	173153	20.0	146740	29.1	213507	21.9	160680
5	22678	28.0	634,984	29.5	669001	16.5	374187	23.1	523862	27.7	628181
6	12673	27.9	353,577	8.3	105186	23.0	291479	10.2	129265	13.9	176155
7	7337	17.9	131,332	5.1	37419	24.9	182691	5.3	38886	20.1	147474
8	11339	25.5	289,145	26.5	300484	26.6	301617	17.2	195031	19.9	225646
9	11339	24.4	276,672	35.1	397999	26.9	305019	23.0	260797	24.3	275538
10	2001	37.9	75,838	61.0	122061	36.2	72436	35.0	70035	66.8	133667
11	12673	17.7	224,312	17.3	219243	22.0	278806	19.2	243322	20.1	254727
12	14007	28.7	402,001	29.9	418809	22.5	315158	22.8	319360	21.9	306753
13	18009	66.3	1,193,997	151.7	2731965	135.3	2436618	133.5	2404202	163.2	2939069
14	17342	60.8	1,054,394	90.9	1576388	80.2	1390828	80.9	1402968	110.6	1918025
15	6003	30.3	181,891	46.6	279740	100.6	603902	120.8	725162	110.9	665733
16	22678	24.7	560,147	13.1	297082	6.1	138336	30.0	680340	53.4	1211005
	210772		10,278,603		11,416,839		13,567,314		14,263,061		12,389,725

Catchment No.	Area (km^2)	17 July 2004		18 July 2004		6 October 2004		7 October 2004		17 June 2005	
1	15341	250.3	3839852	221.3	3394963	2.4	36,818	7.4	113523	170.8	2,620,243
2	14007	65.7	920260	61.4	860030	28.7	402,001	10.8	151276	38.7	542,071
3	16008	225.3	3606602	203.1	3251225	12.4	198,449	14.6	233717	120.2	1,924,162
4	7337	7.7	56495	20.8	152610	43.8	321,361	24.3	178289	7.6	55,761
5	22678	0.5	11339	30.0	680340	63.8	1,446,856	44.6	1011439	97.2	2,204,302
6	12673	5.3	67167	11.5	145740	47.3	599,433	43.2	547474	22.6	286,410
7	7337	7.5	55028	5.7	41821	35.9	263,398	35.6	261197	3.3	24,212
8	11339	3.6	40820	29.2	331099	64.7	733,633	70.8	802801	38.5	436,552
9	11339	1.9	21544	29.8	337902	50.4	571,486	70.0	793730	10.8	122,461
10	2001	17.7	35018	29.1	58229	41.5	83,042	81.9	163882	13.4	26,831
11	12673	11.5	145740	23.0	291479	77.1	977,088	101.6	1287577	7.7	97,582
12	14007	16.1	225513	27.2	380990	144.9	2,029,614	149.7	2096848	8.9	124,662
13	18009	63.4	1141771	11.3	203502	47.5	855,428	71.8	1293046	40.9	736,568
14	17342	47.6	825479	26.4	457829	52.7	913,923	98.4	1706453	15.5	268,801
15	6003	113.2	679540	14.9	89445	99.5	597,299	153.0	918459	71.0	426,213
16	22678	20.0		44.3	1004635	5.3	120,193	14.2	322028	5.7	129,265
	210772				11,681,838		10,150,073		11,881,738		10,026,077

significant system. Consequent upon a very heavy down pour during period (2002-2007) over NE region was observed by the observation of R/F at 0830 hrs on the following day, *i.e*., 08 July 2004. The AAP's value area and quantity of down pour water in metric tons catchment wise is shown in the Table 2. This day down pour water over NE region is 6.58 times the average daily downpour during monsoon seasons of 2002-2007.

Case 3

Date 08 July 2004

A sea level trough was passing from Punjab to NE Assam on SLC of 0000 UTC. There was no other significant system. Consequent upon a very heavy down pour during period (2002-2007) over NE region was observed by the observation of R/F at 0830 hrs on the following day *i.e*., 09 July 2004. The AAP's value area and quantity of down pour water in metric tons catchment wise is shown in the Table 2. This day down pour water over NE region is 7.82 times the average daily downpour during monsoon seasons of 2002-2007.

Case 4

Dated 09 July 2004

A sea level-trough was passing through foot of Himalayas on SLC of 0000 UTC. There was no other significant system. Consequent upon the heaviest down pour during period (2002-2007) over NE region was observed by the observation of R/F at 0830 hrs on the following day *i.e*., 10 July 2004. The AAP's value area and quantity of down pour water in metric tons catchment wise is shown in the Table 2. This day down pour water over NE region is 8.22 times the average daily downpour during monsoon seasons of 2002-2007.

Case 5

Date 10 July 2004

A sea level trough was passing through foot of Himalayason SLC of 0000 UTC. There was no other significant system. Consequent upon a very heavy down pour during period (2002-2007) over NE region was observed by the observation of R/F at 0830 hrs on the following day *i.e*., 11 July 2004. The AAP's value area and quantity of down pour water in metric tons catchment wise is shown in the Table 2. This day down pour water over NE region is 7.14 times the average daily downpour during monsoon seasons of 2002-2007.

Case 6

Date 17 July 2004

A sea level trough was passing from Bihar to NE Assam & also another trough from Rajasthan to NE Bay Of Bengal on SLC of 0000 UTC. There was a low pressure area over east Madhya Pradesh. Consequent upon a very heavy down pour during period (2002-2007) over NE region was observed by the observation of R/F at 0830 hrs on the following day *i.e*., 18 July 2004. The AAP's value area and quantity of down pour water in metric tons catchment wise is shown in the Table 2. This day down pour water over NE region is 6.99 times the average daily downpour during monsoon seasons of 2002-2007.

Case 7

Date 18 July 2004

A sea level trough was passing from Punjab to NE Assam on SLC of 0000 UTC. There was no other significant system. Consequent upon a very heavy down pour during period (2002-2007) over NE region was observed by the observation of R/F at 0830 hrs on the following day *i.e*., 19 July 2004. The AAP's value area and quantity of down pour water in metric tons catchment wise is shown in the Table 2. This day down pour water over NE region is 6.73 times the average daily downpour during monsoon seasons of 2002-2007.

Case 8

Date 06 October 2004

A sea level trough was passing from GWB to North East Assam on SLC of 0000 UTC. There was also a low pressure area over Orissa. Consequent upon a very heavy down pour during period (2002-2007) over NE region was observed by the observation of R/F at 0830 hrs on the following day *i.e*., 07 October 2004. The AAP's value area and quantity of down pour water in metric tons catchment wise is shown in the Table 2. This day down pour water over NE region is 5.85 times the average daily downpour during monsoon seasons of 2002-2007.

Case 9

Date 07 October 2004

No sea level trough was seen SLC of 0000 UTC. However a Deep Depression lies over Orissa extending upto Mid Tropospheric Level. Consequent upon a very heavy down pour during period (2002-2007) over NE region was observed by the observation of R/F at 0830 hrs

on the following day *i.e*., 08 October 2004. The AAP's value area and quantity of down pour water in metric tons catchment wise is shown in the Table 2. This day down pour water over NE region is 6.85 times the average daily downpour during monsoon seasons of 2002-2007.

Case 10

Date 17 June 2005

A sea level trough was passing from East U.P. to head Bay of Bengal on SLC of 0000 UTC. There was also a cycir over North-East Assam extending upto 0.9 km ASL. Consequent upon a very heavy down pour during period (2002-2007) over NE region was observed by the observation of R/F at 0830 hrs on the following day *i.e*., 18 June 2005. The AAP's value area and quantity of down pour water in metric tons catchment wise is shown in the Table 2. This day down pour water over NE region is 5.78 times the average daily downpour during monsoon seasons of 2002-2007.

4. It is found that :

(a) Out of ten heavy downpour cases four are due to the sea level trough passing from Punjab to North East Assam on SLC of 0000 UTC and two cases are due to a sea level-trough was passing through foot of Himalayas on SLC of 0000 UTC. Also heavy downpour cases observed when

(*i*) A sea level trough was passing from Bihar to North East Assam & also another trough from Rajasthan to NE Bay of Bengal on SLC of 0000 UTC. There was a low pressure area over east Madhya Pradesh.

(*ii*) No sea level trough was seen SLC of 0000 UTC. However a Deep Depression lies over Orissa extending upto Mid Tropospheric Level.

(*iii*) A sea level trough was passing from GWB to North East Assam on SLC of 0000 UTC. There was also a low pressure area over Orissa.

(*iv*) A sea level trough was passing from East U.P. to head Bay of Bengal on SLC of 0000 UTC. There was also a cyclonic circulation over North-East Assam extending upto 0.9 km ASL.

(b) The average quantity of downpour water during the season has been worked out as 1,735,529 metric tons/day.

(c) The quantity of downpour varies from 0 to 14,263,061 metric tons/day over the NE region in the ten cases.

(d) The sub basin 7 and 11 get minimum rainfall while the heavy downpour has occurred in the region.

(e) Most of the event was occurred during the year 2004.

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